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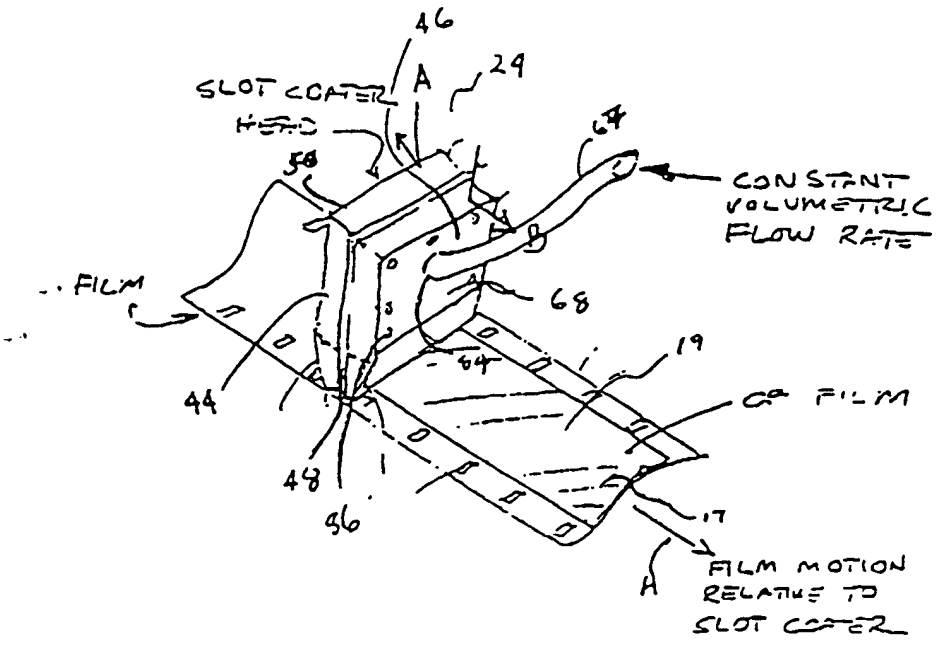
(54) Title: SLOT COATING DEVICE FOR ELECTRONIC FILM DEVELOPMENT



(57) Abstract: A slot coater device is provided for applying a processing solution (19), such as developer, to film development. The slot coater (22) includes a housing having an opening for dispensing the processing solution, a reservoir within the housing adapted to receive a predetermined amount of the processing solution (19), and a channel for delivering the processing solution from the reservoir to the opening.

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SLOT COATING DEVICE FOR ELECTRONIC FILM DEVELPMENT

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to film processing and, particularly, to a slot coater system and method of operation.

DESCRIPTION OF THE RELATED ART

In developing photographic film, a number of processing solutions are generally used to develop and stabilize the image on the photographic film. One such method for developing photographic film is traditional chemical film development. The traditional chemical film development process generally includes the steps of developing, stopping, fixing, clearing, washing, drying, and sealant. With the exception of drying, each of these processing steps generally requires the application of a different processing solution to the film. The processing solutions are generally applied to the film by showering or dipping the film in different containers of processing solutions. The used processing solutions are often hazardous chemicals and their disposal is regulated by government agencies.

A relatively new photographic film processing method is digital film development. Digital film development is a method of electronically digitizing the

images stored on the film during the film development process. In electronic development, the electronic digitizing process involves scanning the film through the processing solution. In other words, when the image on the film is scanned, the film is still wet with processing solutions. As a result, it is desirable to uniformly apply the processing solution to the film.

Conventional methods have the disadvantage of failing to provide a uniform application of processing solutions. Another disadvantage of conventional processes is the requirement for disposal of used and excess processing solutions.

SUMMARY OF THE INVENTION

These and other drawbacks are overcome in large part by a system and method according to the present invention. Briefly summarized, a slot coater system and method of operation are provided for applying processing solutions to film. In one embodiment of the present invention, a slot coater is provided. In this embodiment, the slot coater includes a housing having an opening for dispensing a processing solution, a reservoir within the housing adapted to provide a substantially uniform pressure across the width of the housing, and a channel for delivering the processing solution from the reservoir to the opening. According to a particular embodiment, the slot coater is formed as a replaceable cartridge.

In another embodiment of the present invention, a film processing system is provided. In this embodiment, the film processing system comprises a delivery system that includes a slot coater operable to apply a processing

solution to film. In a particular embodiment, the film processing system further comprises an imaging station operable to digitize an image on the film.

One or more embodiments of the invention provide important technical advantages. Various embodiments of the invention may have none, some, or all of these advantages. For example, in some embodiments, the slot coater has the advantage of applying a substantially uniform coat of processing solutions on the film. Another advantage is that the slot coater uses relatively little processing solution relative to conventional viscous film processing fluid. As such, disposal of excess film processing fluid is not required.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the invention is obtained when the following detailed description is considered in conjunction with the following drawings, wherein like reference numerals represent like features, in which:

FIG. 1 is a block diagram of a film processor in accordance with one embodiment of the invention;

FIG. 2 is a diagram of an electronic film development system in accordance with one embodiment of the invention;

FIG. 3 is a diagram of a slot coater head for use in the electronic development system of FIG. 2;

FIG. 4A and 4B are side elevations of the slot coater of FIG. 3;

FIGS. 5A-5C are plan views of the components of the slot coater of FIG. 3;

FIG. 6A and 6B are separate embodiments of slot coater cartridges in

accordance with the invention;

FIG. 7A – 7C are additional embodiment of slot coater cartridges in accordance with the invention;

FIG. 8 is a capping station in accordance with one embodiment of the invention;

FIGS. 9A-9H illustrate leak controllers according to particular implementations of the invention; and

FIG. 10 illustrates an edge slot coater dispenser according to a particular implementation of the invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGS. 1-10 illustrate a slot coater system and method of operation. As will be discussed in greater detail below, the slot coater system includes a slot coater head adapted to receive and apply a processing solution to film. The slot coater system according to the present invention provides a substantially even layer of processing solution to the film.

Turning now to the drawings and, with particular attention to FIG. 1, a film processor 10 according to one embodiment of the invention is illustrated. In this embodiment, the film processor 10 includes a film transport system 12, a processing solution delivery system 14, and a film processing system 16.

The film transport system 12 operates to receive, dispense and transport a film 17 through the various stations within the film processor 10. In one embodiment, the film transport system 12 comprises a series of rollers that frictionally contact the film 17 to move the film. In another embodiment, the film

transport system 12 comprises a parallel system of bands that pinch the edges of the film and guide the film 17 through the film processor 10. The film transport system 12 may comprise any suitable device or system for transporting film.

As described in greater detail below, the delivery system 14 includes a slot coater assembly for applying a layer of a processing solution 19 to the film 17. In one embodiment of delivery system 14, a single slot coater assembly is used to coat the processing solution 19 onto the film 17. In another embodiment, multiple slot coaters are used to apply multiple or different processing solutions 19 to the film 17. The different processing solutions 19 applied by the slot coater can also be applied before and after various stages of processing the film 17.

The processing solution 19 dispensed by the delivery system 14 may include any suitable film processing fluid. The specific type of processing solution 19 will depend upon the particular type of film processor 10. For example, in one embodiment of film processor 10, the processing solution 19 comprises a developer solution that is applied to the film. In other embodiments of film processor 10, different processing solutions 19 are applied to the film 17 using separate slot coaters or delivery systems 14. For example, the processing solution 19 may comprise a developer such as HC-110 combined with a thickening agent such as hydroxyethylcellulose having a viscosity of about 25 to 30,000 cps. Other film processing fluids, such as sodium hydroxide as an accelerator, stop solution, fixer solution, blix solution, water, or bleach solution as these chemical solutions are known in the photographic industry. It will also

be understood that the processing solution 19 may be any other suitable type of fluid used in the film development process, such as silver halide emulsion containing couplers.

A more detailed view of one embodiment of a film processor 10 and, particularly, an electronic film processing system according to the present invention, is shown in FIG. 2. The film processor 10 is controlled by one or more processing units 18. The processing unit 18 may be embodied as a PC or PC compatible computer employing a Pentium or compatible processor, or RS 6000 workstation available from IBM Corporation. The processing unit 18 is programmed to control operation of the film processor 10 and to process images received there from, as will be explained in greater detail below.

The film processor 10 is loaded with film 17 at the film transport system 12. The film 17 may be any standard film such as 35 mm film or Advanced Photo System (APS) film, available from Eastman Kodak Co., Rochester, New York. The film transport system 12 provides the film 17 to the delivery system 14 according to the present invention.

According to one embodiment of the present invention, the delivery system 14 includes a slot coater assembly 22 for applying the processing solution 19 to the film 17. The slot coater assembly 22 may include a slot coater head 24 and a dispenser system 26 for providing processing solution to the slot coater head 24. As will be discussed in greater detail below, the dispenser system 26 may comprise any suitable system operable to dispense the processing solution 19 to the slot coater head 24.

As shown in FIG. 2, the delivery system 14 includes a locating system 28,

such as a step motor, for controlling the placement of the slot coater head 24 onto the film 17. In addition, a capping station 30 may be provided to seal the slot coater head 24 when not in use. The capping station 30 may further be used to wipe clean the slot coater head 24 and provide a receptacle for the processing solution 19 when priming or purging the slot coater head 24. A transport subsystem 31, which may include a step motor 32 and rollers 34, 36, may be provided as part of the film transport system 12 to advance the film 17 through the delivery system 14.

Once the processing solution 19 has been applied to the film 17, the film 17 is advanced toward the film processing system 16. In the electronic film development embodiment illustrated, the film processing system 16 comprises one or more imaging stations 37. In one embodiment, the film processing system 16 comprises a single imaging station 37. In another embodiment, the film processing system 16 comprises multiple imaging stations 37 that operate to scan the film 17 at multiple development times. For simplicity, only one imaging station 37 is fully illustrated in FIG. 2. Imaging station 37 comprises an illumination system 39. In the embodiment illustrated, the illumination system 39 comprises one or more illuminators 38a-38d, which provide for scanning along paths 40a-40d, respectively. The paths 40a-40d may include one or more wave-guides for focusing the light onto film 17. In another embodiment, the illumination system 39 comprises one or more lenses.

The illumination system 39 operates to illuminate the film 17 with electromagnetic energy, i.e., light. In one embodiment, the illumination system 39 produces visible light, i.e., light within the electromagnetic spectrum that is

visible to the human eye. In another embodiment, the illumination system 39 produces infrared light. In yet another embodiment, the illumination system 39 operates to produce visible and infrared light concurrently and alternatively, such as through the use of a color wheel.

The imaging station 37 also comprises a sensor system 41 operable to sense the electromagnetic from the illumination system 39. In the embodiment illustrated, the sensor system 41 comprises one or more digital image capturing devices, such as cameras 42a, 42b. The cameras 42a, 42b may be embodied as linear charge coupled device (CCD) arrays, such as CCD arrays available from DALSA. The images are then provided along a known interface (not shown), such as a parallel port interface, to the processing unit 18.

In the embodiment of electronic film processing system illustrated, the opposing pair of cameras 42a, 42b receive light reflected from the front (emulsion side), back (base side) and transmitted through the film 17 for each pixel, which are then resolved by the processing unit 18 in a known manner. One such method is described in U.S. Patent No. 5,519,510, which is hereby incorporated by reference in its entirety as if fully set forth herein.

One embodiment of the slot coater head 24 is illustrated in greater detail in FIGS. 3-5. According to the embodiment illustrated, the slot coater head 24 includes a housing having an anterior portion 44 and a posterior portion 46. A shim 48 having predetermined thickness separates the anterior portion 44 and the posterior portion 48.

The anterior portion 44 (FIGS. 3, 4A, 5C) includes an external face 50, an internal face 52, and side surfaces 54, 56. The side surfaces 54, 56 may

include beveled portions 58, 60 respectively, which taper to a predetermined width to the surface 62. The external face 50 also may include a beveled portion 64, which tapers to the surface 62. As will be discussed in greater detail below, the anterior portion 44 may further include a trough or reservoir 66 for holding developer, which is provided via a feed pipe 67.

The posterior portion 46 (FIGS. 3, 4A, 5A) includes an external face 68, an internal face 70, and side surfaces 72, 74. The side surfaces 72, 74 may include beveled portions 76, 78, which taper to the surface 80, to match the surface 62 of the anterior portion 44. The external surface 68 may include a beveled portion 82, which tapers to the flat edge 80.

The feed pipe or tube 67 may be provided to a hole 84 in the external surface 68 of the posterior portion 46. As shown, the hole 84 extends through the posterior portion 46 and, with the feed pipe 67, allows the processing solution 19 to enter the slot coater head 24 at a constant volumetric rate. The processing solution 19 is provided via the hole 84 to the reservoir 66. The reservoir 66 functions to prevent a pressure gradient across the direction of flow. It is noted that while shown in face 68, the hole 84 may be provided through any other surface. Similarly, the reservoir 66 may be provided at a variety of locations internally. Moreover, in other embodiments, a reservoir 66 may not be necessary. Thus, the figures are exemplary only.

A series of holes 86 may be provided as screw holes in both the anterior portion 44 and the posterior portion 46 to allow screws (not shown) to secure the anterior portion 44 to the posterior portion 46 and the shim 48 there between.

The shim 48 (FIG. 5B) is relatively thin and, when secured between the anterior portion 44 and the posterior portion 46, provides a sealed channel through which the developer may be applied. The shim 48 includes a base portion 88 and extending members 90, 92. The base portion 88 and the extending members 90, 92 include screw holes to match those of the anterior and posterior portions. It is noted that in some embodiments, a shim is not necessary; the desired gap may be directly formed into the anterior and/or posterior portions. The interior surfaces 94, 96 of the extending members 90, 92, and the interior surface 98 of the base portion 88, in conjunction with the interior surfaces 52, 70, of the anterior portion 44 and the posterior portion 46, define the channel of width *T* for the developer. The width *T* is chosen to allow developer to be applied to the film's emulsion layer.

Further, as seen in FIG. 4B, the anterior portion 44 and the posterior portion 46 are separated by the shim (not shown) at a distance *t*. The slot or channel width *t* is chosen to optimize the coating process. Finally, the surfaces 62, 80 of the anterior and posterior portions 44, 46 are maintained at a gap width 100, such as 50 to 500 microns, above the film layer 20. Finally, the slot coater head 24 may be positioned at an angle of about 80-100 degrees with respect to the film surface.

It is noted that in alternate implementations, the slot coater head 24 is applied directly to the surface of the film 17. In one such alternate implementation, the slot coater head 24 includes a porous material (not shown), such as a felt-like material, a brush-like material, or a plurality of capillaries, occupying at least a portion of the slot. The porous material may be positioned

to directly coat the surface of the film 17. Thus, the figures are exemplary only.

An exemplary slot coater assembly 22a is shown in FIG. 6A. The slot coater assembly 22a includes the slot coater head 24a and a replaceable collapsible, reticulated or accordion-like cartridge 102a. The replaceable cartridge 102a may be embodied in the illustrated accordion-like configuration or may be embodied as any similar cartridge whereby developer may be provided to the slot coater head 24a at a controlled volumetric rate. For example, the replaceable cartridge 102a may be embodied as a syringe or syringe-like mechanism, or as a collapsible bladder. Further, the cartridge 102a may be reusable and capable of being refilled.

The cartridge 102a may be a part of a dispenser 12a. As illustrated, the dispenser 12a includes a base unit 104a having one or more support members 106a, 108a. The forward support member 106a includes a notch or hole 110a whereby the feed pipe 67a may be provided from the cartridge 102a to the slot coater head 24a.

The dispenser 12a further may include a driving unit 114a. The driving unit 114a may be embodied as a motor such as a step motor 116a, which drives a driving member 118a such as a lead screw. The rear support member 108a includes a notch or hole 120a to support the driving member 118a. One end of the driving member 118a is fixed to a coupler 122a, which is coupled to or abuts an end of the cartridge 102a. The other end of the driving member 118a is provided to the motor 116a, shown fixed to the base unit 104a. The motor 116a causes the driving member 118a to be propelled in the direction of the cartridge 102a at a constant rate such that developer is provided from the cartridge 102a

out the lead pipe 110a and into the slot coater head 24a. Finally, the slot coater head 24a may be fixed to rotate about axis C, for example, via actuation of the locating system 28 (FIG. 2).

An alternative embodiment of a slot coater assembly 22b is shown in FIG. 5B. The embodiment of FIG. 6B employs a syringe pump to provide the developer to the slot coater head 24b. The slot coater assembly 22b of FIG. 6B includes a slot coater head 24b and a cartridge 102b such as a syringe.

The syringe 102b may be part of a dispenser 12b. As illustrated, the dispenser 12b includes a base unit 104b having one or more support members 106b, 108b. The forward support member 106b includes a notch or hole 110b whereby the feed pipe 67b may be provided from the syringe 102b to the slot coater head 24b.

The dispenser 12b may include a driving unit 114b. The driving unit 114b may be embodied as a motor such as a step motor 116b coupled to a driving member 118b. The driving member 118b may be embodied as a lead screw. The rear support member 108b includes a notch or hole 120b to support the driving member 118b. The driving member 118b is fixed to a pusher 124a by way of a coupler 122b and is used to push the developer toward the feed pipe end of the syringe 102b. The driving member 118b is also provided to the motor 116b, shown fixed to the base unit 104b. The motor 116b causes the driving member 118b to move the pusher 124a in the slot coater direction at a constant rate such that processing solution is provided from the syringe 102b out the lead pipe 67b and into the slot coater head 24b. Again, the slot coater head 24b may be fixed to rotate about axis C.

In the embodiments shown in FIGS. 6A and 6B, the slot coater head 24 is formed as a separate unit from the cartridge or syringe pump. In such an embodiment, the slot coater head 24 may typically be formed from metal, plastic, or similar material. In alternate embodiments, however, the slot coater head and the cartridge or pump may be provided as an integrated, replaceable unit. Exemplary slot coater assemblies employing integrated slot coater heads 24 are shown in FIGS. 7A – 7C.

Turning now to FIG. 7A, an embodiment of an integrated slot coater assembly 22c employing an accordion-like cartridge 102c is illustrated. As shown, the cartridge 102c includes a collapsible portion 125 and a slot coater head 24c. In the embodiment shown, the slot coater head 24c is aligned with the axis of the cartridge 102c. In alternate embodiments, however, the slot coater head 24c may be arranged as a movable unit, as in the embodiments of FIGS. 6A and 6B. The cartridge 102c further includes a base 126, which is formed to receive a coupler 122c, which is attached to an end of a driving member 118c. The driving member 118c, along with a motor 116c, such as a step motor, together form a driving unit 114c.

As shown in FIG. 7A, a support member 108c may support the driving member 118c. A hole or notch 120c may be provided through which the driving member 118c extends. Similarly, a support member 106c having a hole 110c may be provided to support the slot coater head 24c. Finally, it is noted that, while shown in a vertical configuration, the slot coater assembly 22c may be provided at various angles from vertical, so long as the angle between the film 17 and the slot coater head 24c is maintained to allow delivery of the processing

solution 19.

FIG. 7B illustrates a similar embodiment, though employing a syringe pump rather than a collapsible cartridge. In particular, the cartridge 102d is embodied as a syringe which includes a slot coater head 24d integrated therewith. The syringe 102d includes a pusher 124b for pushing against the processing solution 19 and forcing it out the slot coater head 24d. An end of the pusher 124b forms a coupler 122d which is attachable to a driving member 118d, such as a lead screw. The driving member 118d and a motor 116d together form a driving unit 114d. The driving member 118d is driven by the motor 116d in a manner similar to that described above.

An alternative coupling for the slot coater head to the cartridge and/or syringe pump is shown in FIG 7C. In particular, a slot coater head 24e may be coupled to the syringe pump or cartridge 102e by way of a rigid tube 126. In any of the embodiments of FIGS. 7A-C, the slot coater head 24 may be integrated with the cartridge or syringe in a single manufacturing process. The cartridge and syringe pump may be formed with the slot coater head 24 from injection molded or blow molded plastic.

As noted above, a capping station 30 (FIG. 1) may be provided to cap or seal the slot coater head 24 when not in use. Such a capping station 30 is provided to prevent evaporation of the developer or undesirable effects that may result from exposure to air or contaminants. The capping station 30 may also be provided to wipe clean the head of the slot coater 24 and may also be used to provide a reservoir for purging or priming the slot coater.

The capping station 30 may be formed as part of the integrated

cartridge(s) described above with reference to FIGS. 7A-7C or may form a separate unit. One embodiment of a capping station is shown in FIG. 8. The capping station 30 includes a receiving portion 128 which may be dimensioned to fit against the slot coater head 24. In particular, the receiving portion 128 may include beveled portions to match the bevels of the slot coater head 24. As shown, the slot coater head 24 includes a mounting member 130 for mounting on a support 132. The capping station's receiving portion 128 also includes a mounting member 134 for mounting. The receiving portion 128 as shown is slidable along support 132 by way of the mounting member 134 and is attached to an actuator (not shown) which may be provided within the digital film processor. The actuator slides the receiving portion 128 into position against the slot coater head 24 when not in use. The receiving portion 128 may also be provided with a reservoir (not shown) for purging or priming the slot coater.

In addition, as discussed above, the slot coater 24 may be fixed to pivot about axis C (FIG. 6A, 6B) by a locating system 28 (FIG. 2). The locating system 28 then pivots the slot coater head 24 from a position in which it applies processing solution to the film 17 to a position where the capping station's receiving portion 128 may be applied. During rotation, the slot coater head 24 may also be positioned to wipe against the receiving portion 128, so as to provide a degree of cleaning.

Modern electronic cameras code image information as bar codes along the edge of film, for example, between the edge of the film and the film sprocket holes. Such information may include, for example, frame number and film type, and the like. One way to read this information is by using the slot coater to

apply processing solution along the entire surface of the film. To prevent processing solution from leaking through sprocket holes in the film, potentially damaging the imaging system, a leak controller according to an implementation of the invention is provided.

In particular, FIG. 9A illustrates a leak controller 136a positioned to prevent leakage of developer off the film 17 or to clean such developer that does leak. The leak controller 136a may be embodied as any device suitable to either remove or prevent leaks from the film from affecting the transport and imaging system(s).

A particular implementation of a leak controller 136b is illustrated in FIG. 9B. The leak controller 136b is implemented as backing material, such as one or more adhesive tapes applied to the film 17 behind the sprocket holes. Alternatively, the backing material may comprise simply a strip of material held in place by surface tension or the transport mechanism.

FIG. 9C illustrates another approach to leakage control. In particular, the leakage controller 136c of FIG. 9C includes one ore more sprockets 137a-137n having "teeth" that fit within the sprocket holes in the film 17 and thereby prevent the processing solution from leaking through. Sufficient sprockets may be provided for the processing solution 19 to dry enough so that it no longer runs through. A similar approach is shown in the implementation of FIG. 9D. The leak controller 136d is implemented as one or more sprocket belts, again having teeth adapted to fit the sprocket holes of the film 17 and push up processing solution 19 and prevent it from leaking through.

FIGS. 9E and 9F illustrate leak controllers 136 which employ air to control

leakage. In FIG. 9E, the leak controller 136e is implemented as a blower 138 that is used to dry out the processing solution 19 before it can leak through the sprocket holes. The blower 140 may include a heating element 140. The leak controller 136f of FIG. 9F employs one or more suction devices 142a-142n to pull the developer through the sprocket holes so that it does not leak through. Any device suitable to create the desired level of suction may be employed.

The leak controller 136g of FIG. 9G is implemented as one or more flexible or non-flexible squeegee blades 144a-144n that are rotated into position against the underside of the film 17 to remove the processing solution 19 as it falls through the sprocket holes. The processing solution 19 is then removed from the squeegee blades with a doctor blade 146. A similar approach is shown in the leak controller 136h of FIG. 9H. In this case, the processing solution 19 on the squeegee blade or blades 144a-144n is cleaned off on a wheel 148 and the wheel cleaned by another squeegee 146.

An alternative to applying processing solution 19 to the entire surface of the film 17 is to apply processing solution 19 only to the image area of the film 17 and also only to the area of the film 17 containing coded data, thereby ensuring that no processing solution is applied to clog the sprocket holes. An implementation of a slot coater for this purpose is shown in FIG. 10. Shown are film 17 and a slot coater 24. The film 17 includes an image area 149, sprocket holes 150a, 150b, and a coded information area 152. The slot coater 24 may be embodied as a slot coater similar but smaller in form and/or footprint than the slot coater described in FIG. 3 and FIG. 4 above. Alternatively, the slot coater 24 may be implemented as a disposable "pen" having a porous tip 154 that is

maintained in contact with the surface of the film 17. Alternatively, an "ink jet"-type head may be employed to apply the developer to the coded information area 152.

Once the processing solution 19 has been applied, a film processing system similar to that denoted by reference numeral 16 above may be used to read the coded information. The processor 18 may then use this information during development of the image area 149, as generally described above.

The invention described in the above detailed description is not intended to be limited to the specific form set forth herein, but is intended to cover such alternatives, modifications and equivalents as can reasonably be included within the spirit and scope of the appended claims. To aid the Patent Office and any readers of any patent issued on this application in interpreting the claims appended hereto, applicants wish to note that they do not intend any of the appended claims to invoke paragraph 6 of 35 U.S.C. § 112 as it exists on the date of filing hereof unless the words "means for" or "step for" are used in the particular claim.

WHAT IS CLAIMED IS:

1. A film developing system, comprising:

a delivery system including a slot coater for applying a processing solution to film; and

a film processing station for processing the film after application of the processing solution.

2. A film developing system according to claim 1, wherein the film processing station comprises a digital image processing station.

3. A film developing system according to claim 1, wherein the slot coater comprises a collapsible container for dispensing the processing solution.

4. A film developing system according to claim 1, wherein the delivery system further comprises a capping station adapted to cap the slot coater.

5. A film developing system according to claim 1, wherein the processing solution comprises a developer solution.

6. A film developing system according to claim 1, wherein the delivery system includes a pump for delivering the processing solution.

7. A slot coater, comprising:

a housing having an opening for dispensing a processing solution;

a reservoir within the housing adapted to receive the film processing fluid; and

a channel for delivering the film processing fluid from the reservoir to the opening.

8. A slot coater according to claim 7, wherein the slot coater comprises an injection molded material.

9. A slot coater according to claim 7, wherein the processing solution comprises a developer.

10. A slot coater assembly, comprising:

a slot coater operable to coat a processing solution onto a film; and

a dispenser operable to deliver the film processing solution to the slot coater at a substantially constant volumetric rate.

11. A slot coater assembly according to claim 10, wherein the dispenser includes a colapsable container.

12. A slot coater assembly according to claim 10, wherein the dispenser includes a container operable to be refilled with processing solution.

13. A slot coater assembly according to claim 10, wherein the dispenser and the slot coater form an integrated unit.

14. A slot coater assembly according to claim 11, further comprising:

a step motor;

a lead screw driven by said step motor; and

a coupler coupled to the lead screw, wherein the coupler compresses the collapsible container in response to the step motor.

15. A slot coater assembly according to claim 11, wherein the collapsible container and the slot coater form an integrated unit.

16. A method for developing film, comprising:

providing a delivery system having at least one slot coater;

applying at least one processing solution to the film with the slot coater; and

processing the film after application of the processing solution.

17. A method according to claim 16, wherein the processing solution comprises a developer solution.

18. A method according to claim 16, wherein the processing solution comprises a fix solution.

19. A method according to claim 16, wherein the delivery system comprises a first slot coater operable to apply a first processing solution and a second slot coater operable to apply a second processing solution, wherein the first processing solution is different than the second processing solution.

20. A method according to claim 16, wherein processing the film comprises digitizing the film.

21. A film developing system, comprising:

a delivery system comprising a slot coater operable to apply a processing solution to at least a portion of film containing coded information related to developing the film; and

at least one film processing station for processing the film after application of the processing solution.

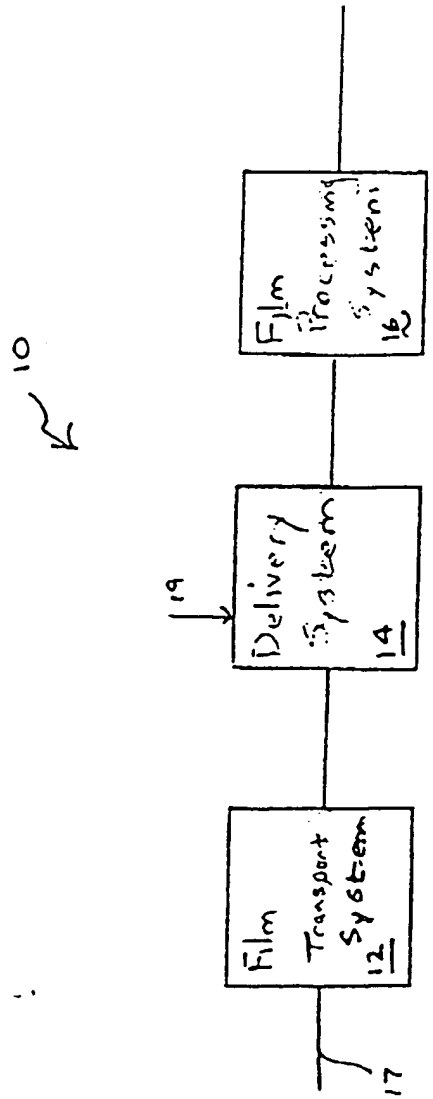
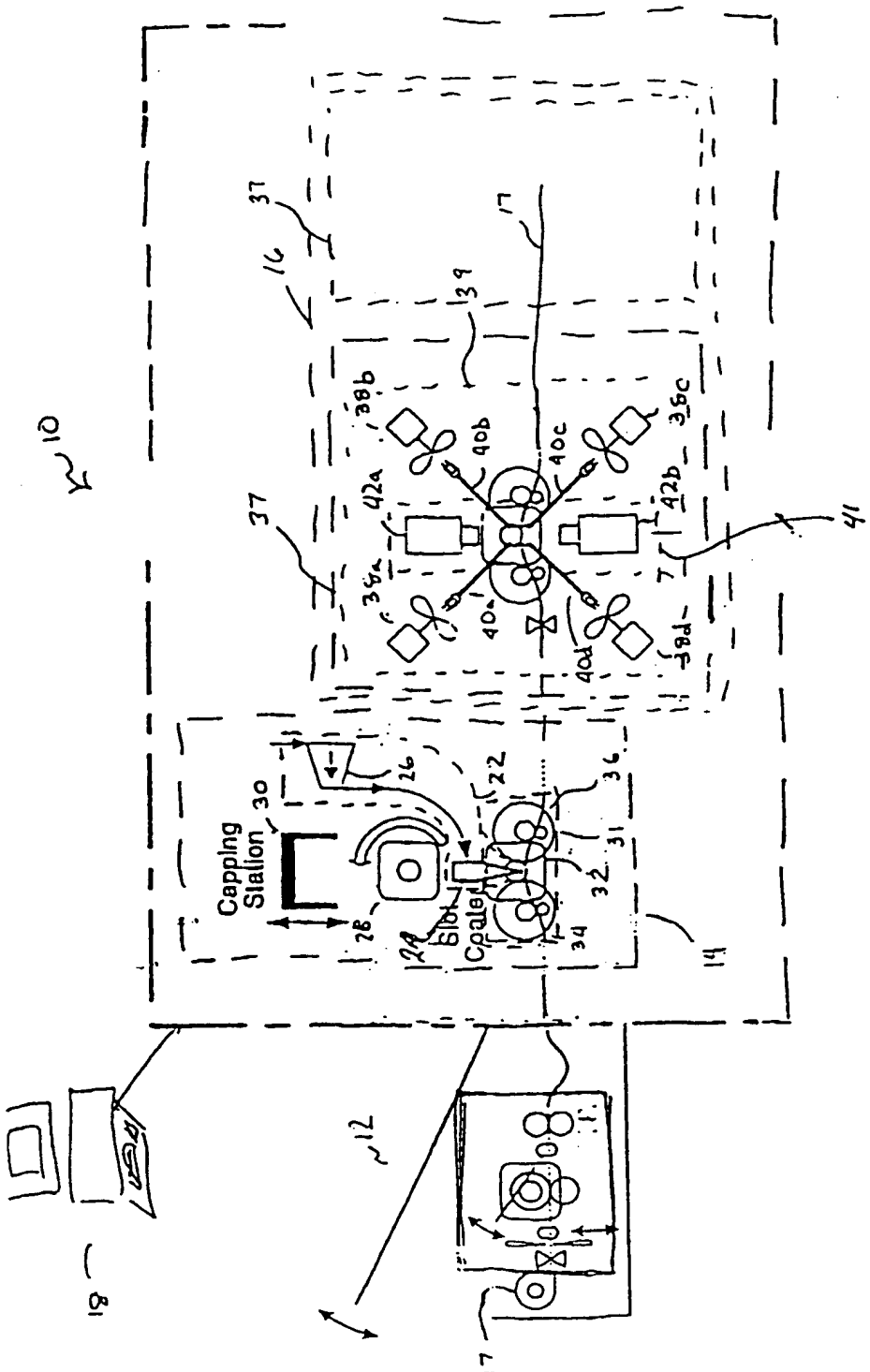


Fig. 1


10
12
14
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26
28
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31
32
34
36
37
38a
38b
38c
38d
39
40a
40b
40c
40d
41
42a
42b
Capping Station
Cradle

FIG. 2

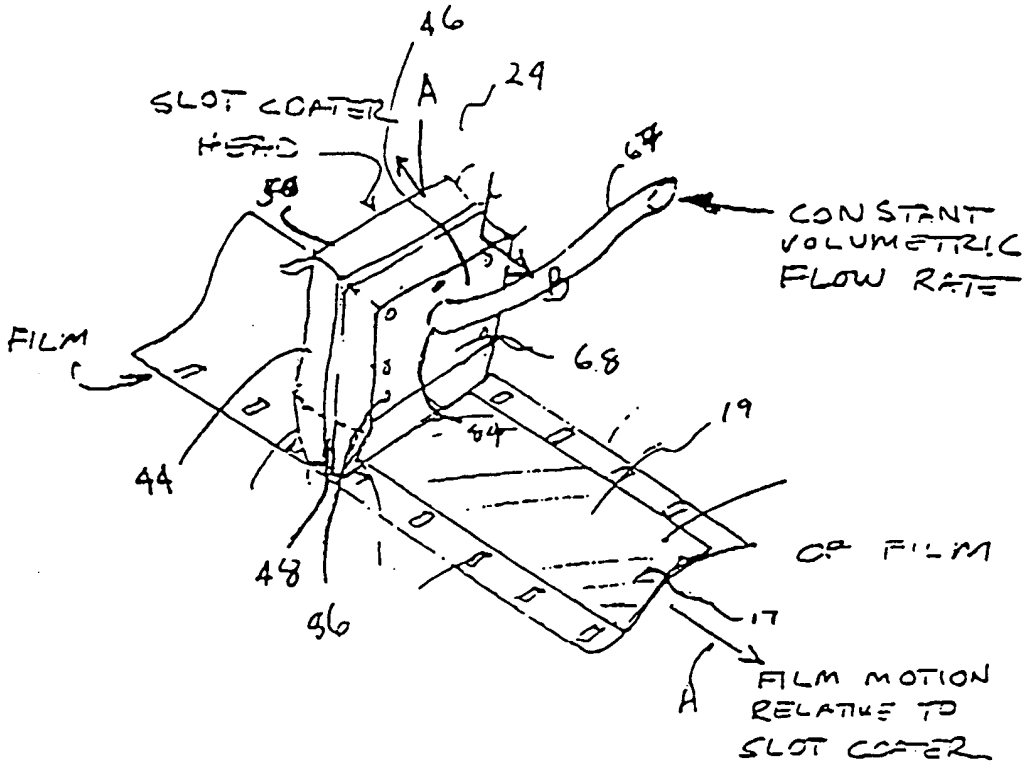

FIG. 3

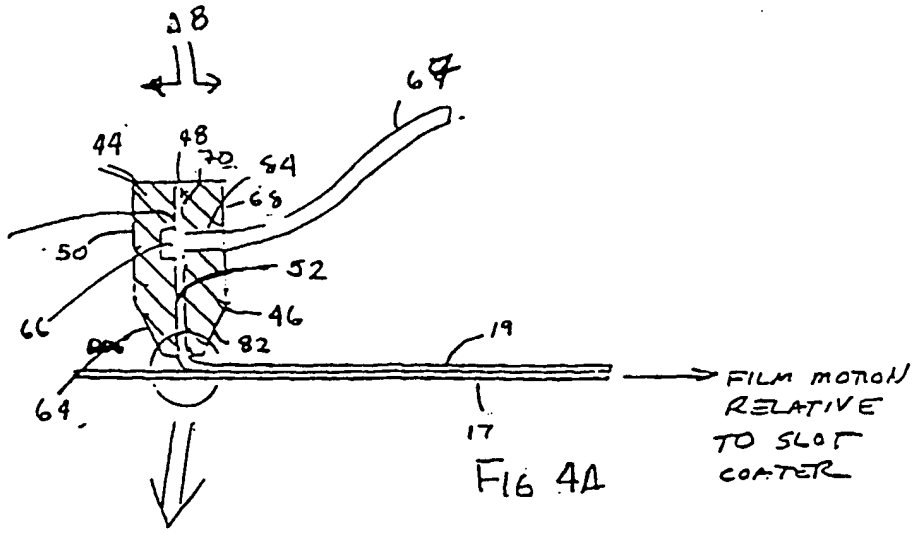

FIG 4A

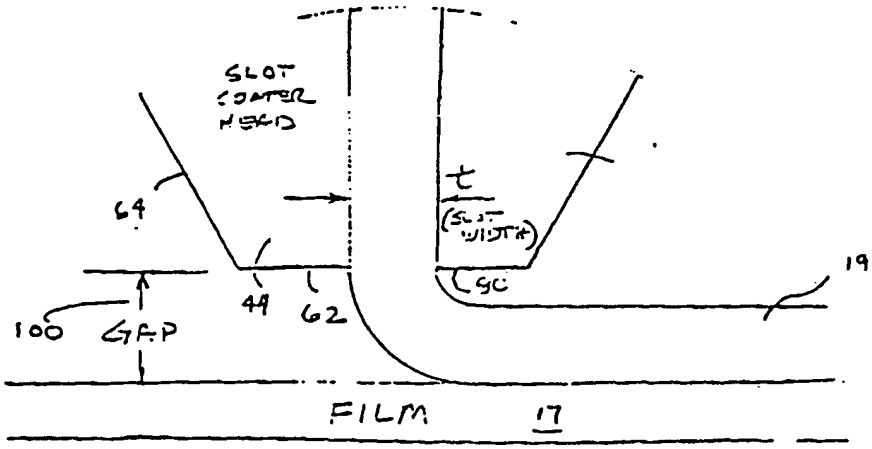

FIG. 4B

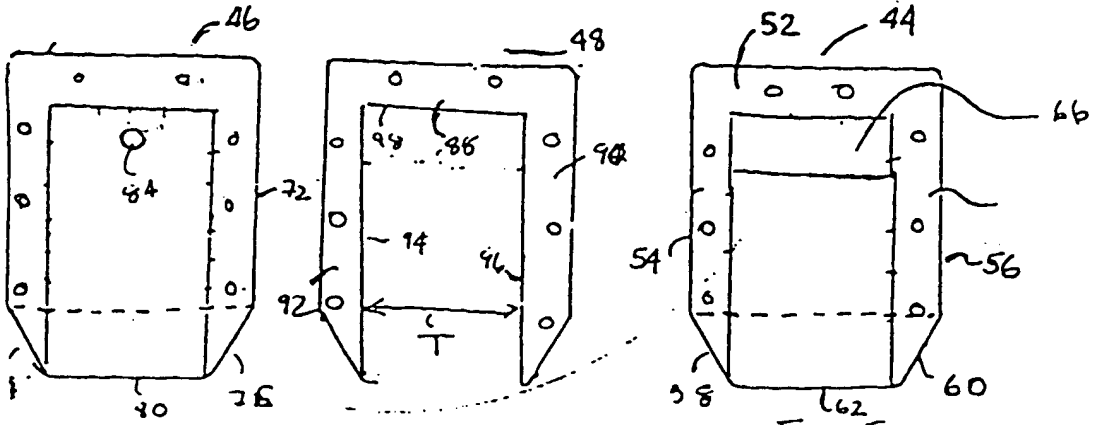

FIG 5A FIG. 5B FIG. 5C

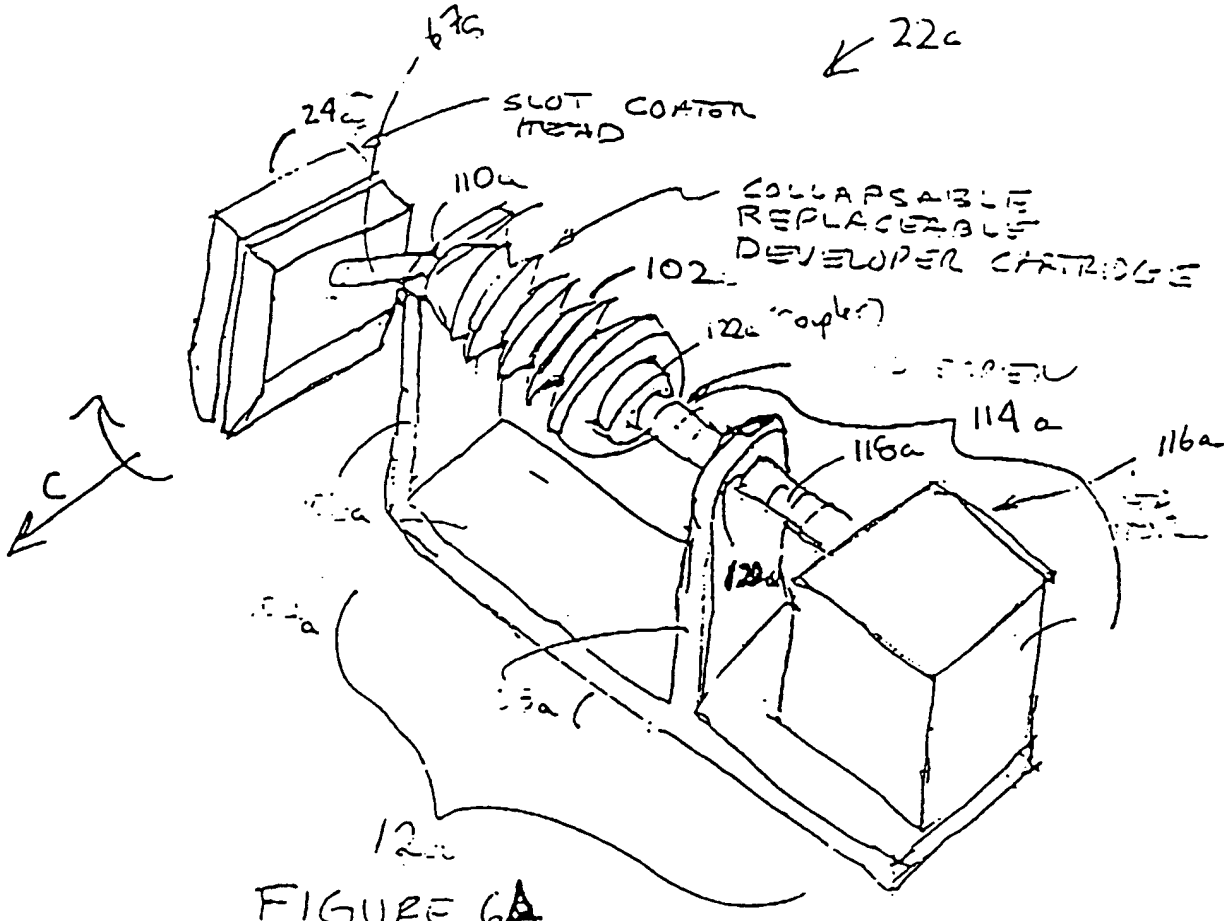
22c
24c
SLOT COATER HEAD
110a
COLLAPSABLE REPLACEABLE DEVELOPER CARTRIDGE
102
122a (coupler)
114a
116a
116a
C
120a
12

FIGURE 6A

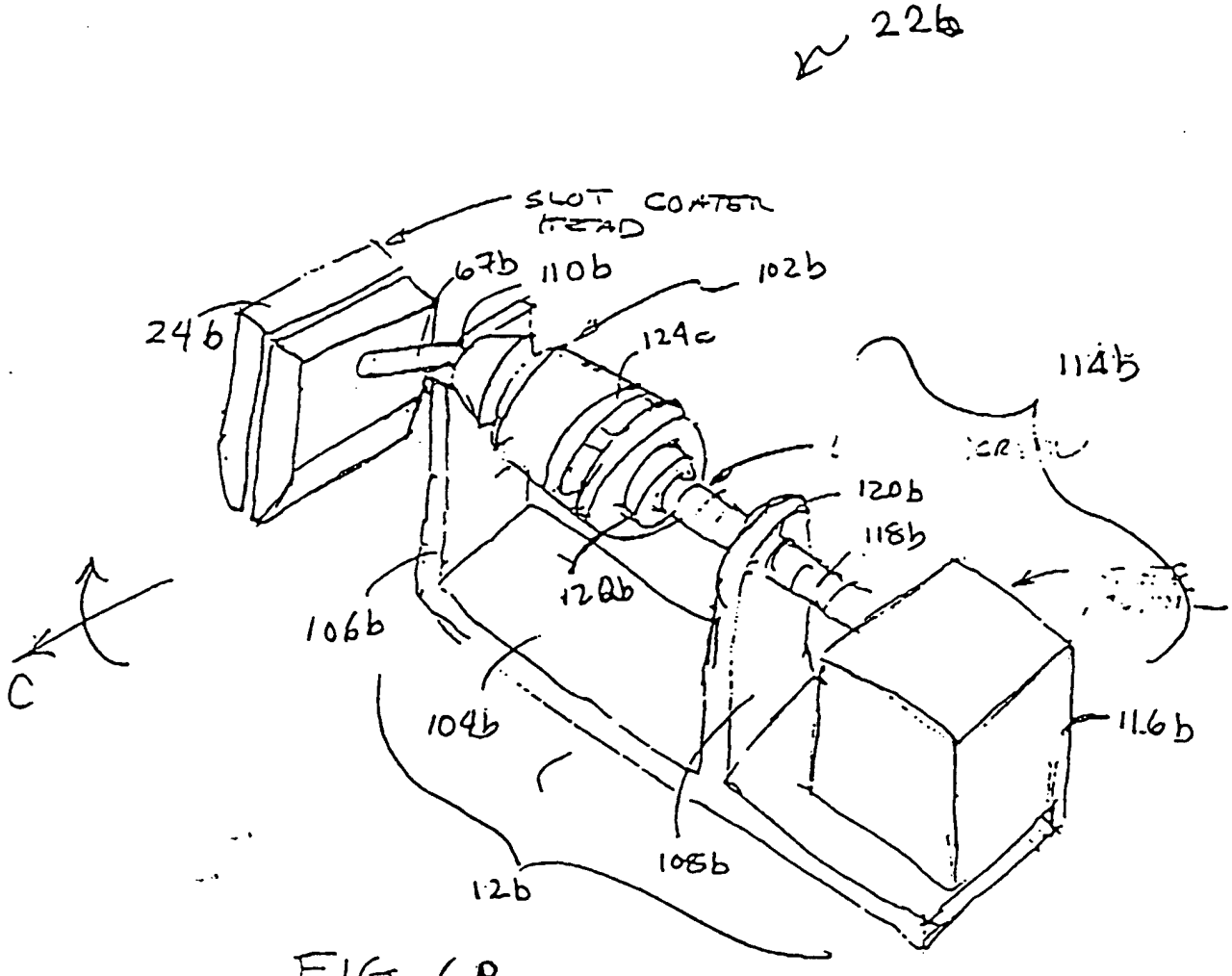
22b
SLOT CENTER HEAD
67b
110b
102b
24b
124c
114b
120b
118b
128b
106b
C
104b
116b
108b
12b

FIG. 6B

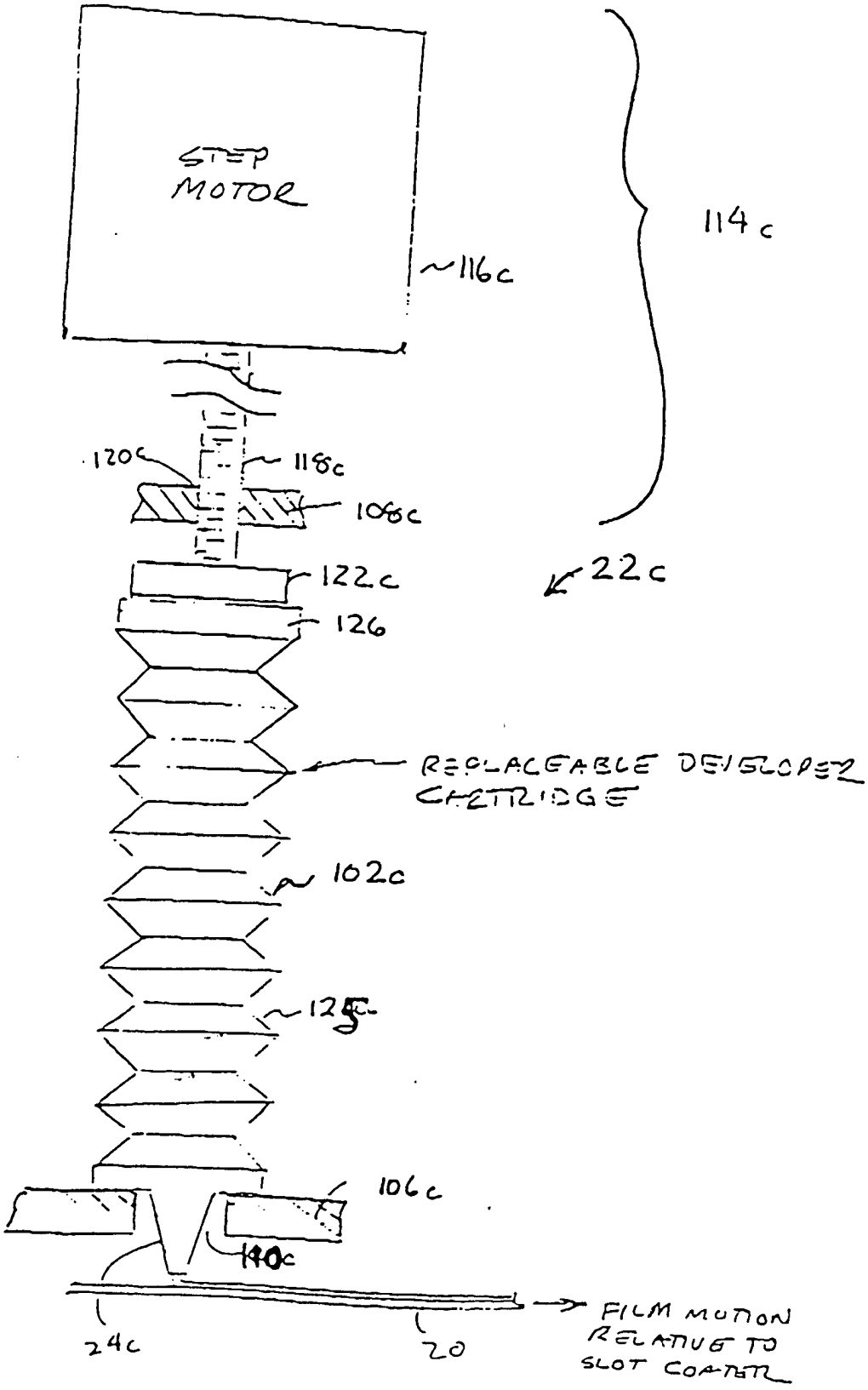
STEP MOTOR
116c
114c
120c
118c
106c
122c
22c
126
REPLACEABLE DEVELOPER CARTRIDGE
102c
125c
106c
110c
FILM MOTION RELATIVE TO SLOT COATER
24c
20

FIGURE 2A

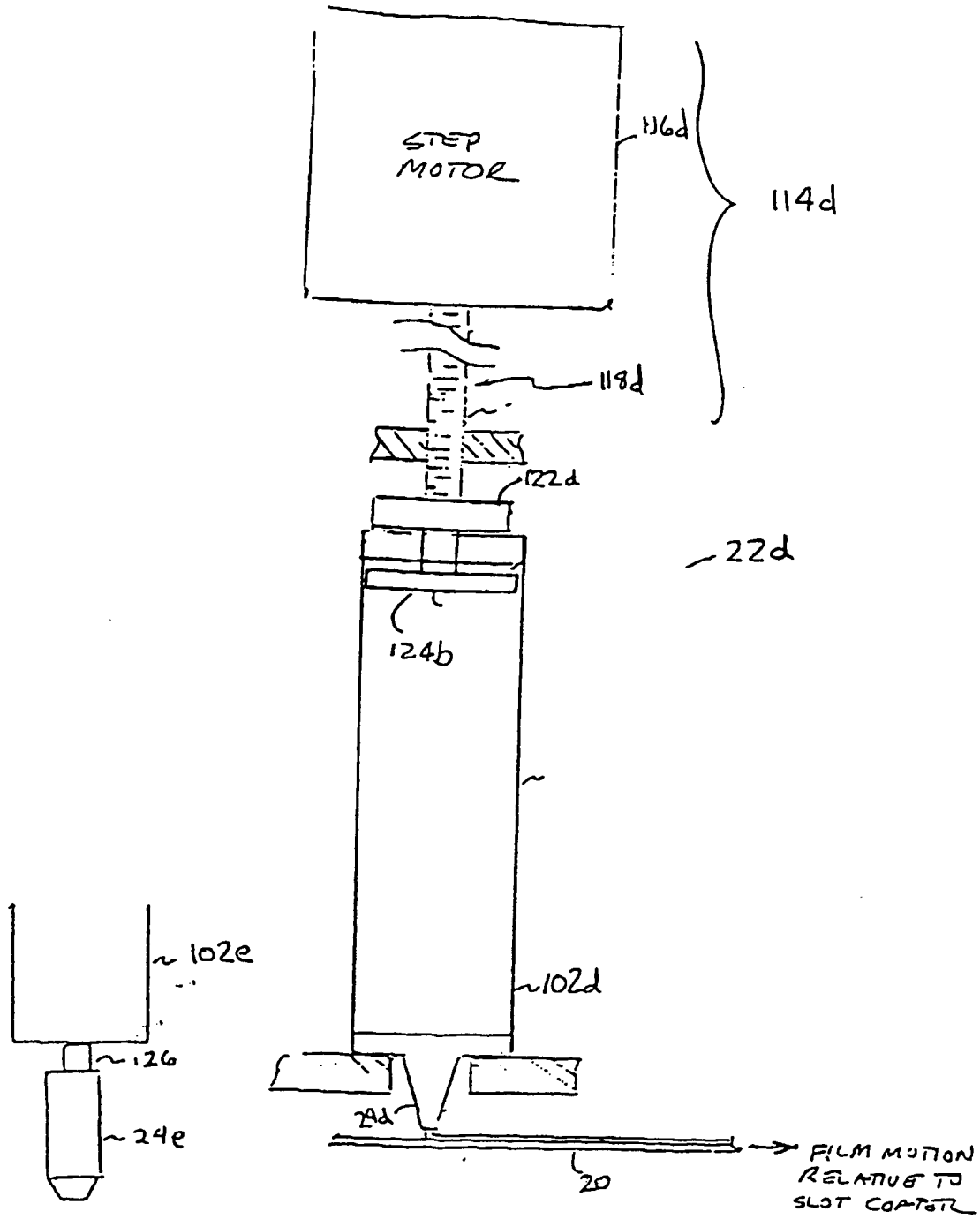

FIG. 7C

FIG. 7B

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(72) Inventors; and

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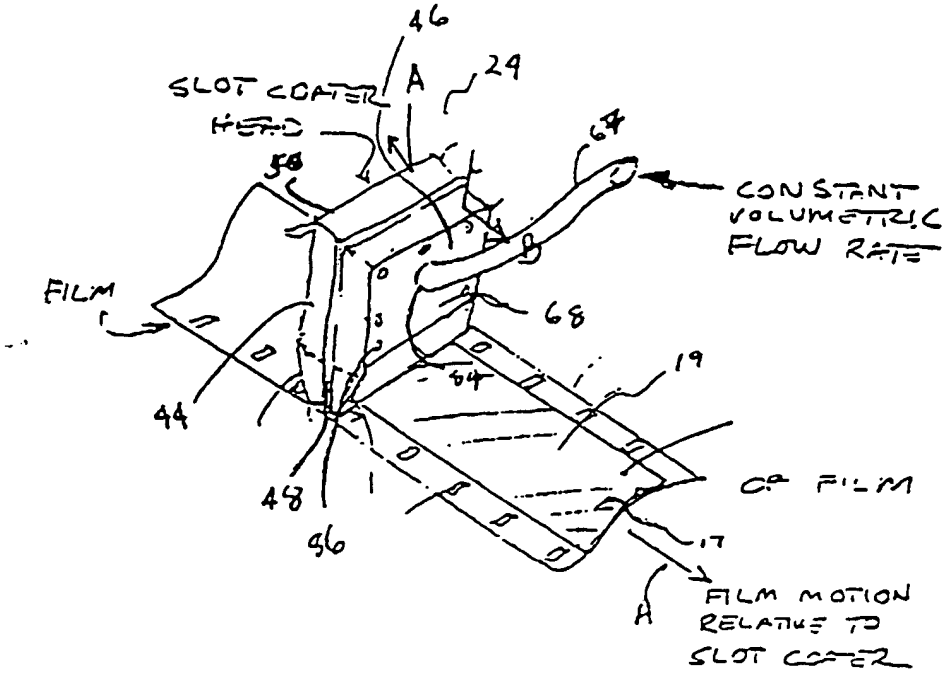
(74) Agents: KOZLOWSKI, Holly, D. et al.; Dinsmore & Shohl LLP, 1900 Chemed Center, 255 East Fifth Street, Cincinnati, OH 45202 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian

[Continued on next page]

(54) Title: SLOT COATING DEVICE FOR ELECTRONIC FILM DEVELOPMENT



(57) Abstract: A slot coater device is provided for applying a processing solution (19), such as developer, to film development. The slot coater (22) includes a housing having an opening for dispensing the processing solution, a reservoir within the housing adapted to receive a predetermined amount of the processing solution (19), and a channel for delivering the processing solution from the reservoir to the opening.

WO 01/01197 A1

patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— *With international search report.*

— *With amended claims.*

Date of publication of the amended claims: 15 February 2001

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

AMENDED CLAIMS
[received by the International Bureau on 4 December 2000 (04.12.00); original claims 1-21 replaced by amended claims 1-18 (4 pages)]

1. A digital film developing system, comprising:

a delivery system including a slot coater for coating a processing solution to film; and

a film processing station for electronically scanning the coated film.

2. A film developing system according to claim 1, wherein the slot coater comprises a collapsible container for dispensing the processing solution.

3. A film developing system according to claim 1, wherein the delivery system further comprises a capping station adapted to cap the slot coater.

4. A film developing system according to claim 1, wherein the processing solution comprises a developer solution.

5. A film developing system according to claim 1, wherein the delivery system includes a pump for delivering the processing solution.

6. A slot coater, comprising:

a housing having a single opening for dispensing a processing fluid onto film;

a reservoir within the housing adapted to receive the film processing fluid; and

a channel for delivering the film processing fluid from the reservoir to the

opening.

7. A slot coater according to claim 6, wherein the slot coater comprises an injection molded material.

8. A slot coater according to claim 6, wherein the processing fluid comprises a developer.

9. A replaceable slot coater assembly, comprising:

a slot coater operable to coat a processing solution onto a film; and

a dispenser operable to deliver the film processing solution to the slot coater at a substantially constant volumetric rate, wherein the dispenser includes a reservoir of processing solution.

10. A slot coater assembly according to claim 9, wherein the reservoir comprises a collapsible container.

11. A slot coater assembly according to claim 9, wherein the reservoir comprises a container operable to be refilled with processing solution.

12. A slot coater assembly according to claim 10, further comprising:

a step motor;

a lead screw driven by said step motor; and

a coupler coupled to the lead screw, wherein the coupler compresses the collapsible container in response to the step motor.

13. A slot coater assembly according to claim 10, wherein the collapsible container and the slot coater form an integrated unit.

14. A method for developing film, comprising:

providing a delivery system having at least one slot coater;

applying at least one processing solution to the film with the slot coater; and

scanning the film with the processing solution on the film.

15. A method according to claim 14, wherein the processing solution comprises a developer solution.

16. A method according to claim 14, wherein the processing solution comprises a fix solution.

17. A method according to claim 14, wherein the delivery system comprises a first slot coater operable to apply a first processing solution and a second slot coater operable to apply a second processing solution, wherein the first processing solution is different from the second processing solution.

18. A film developing system, comprising:

a delivery system comprising a slot coater operable to apply a processing solution to at least a portion of film containing coded information related to developing the film; and

at least one film processing station for processing the film after application of the processing solution in accordance with the coded information.

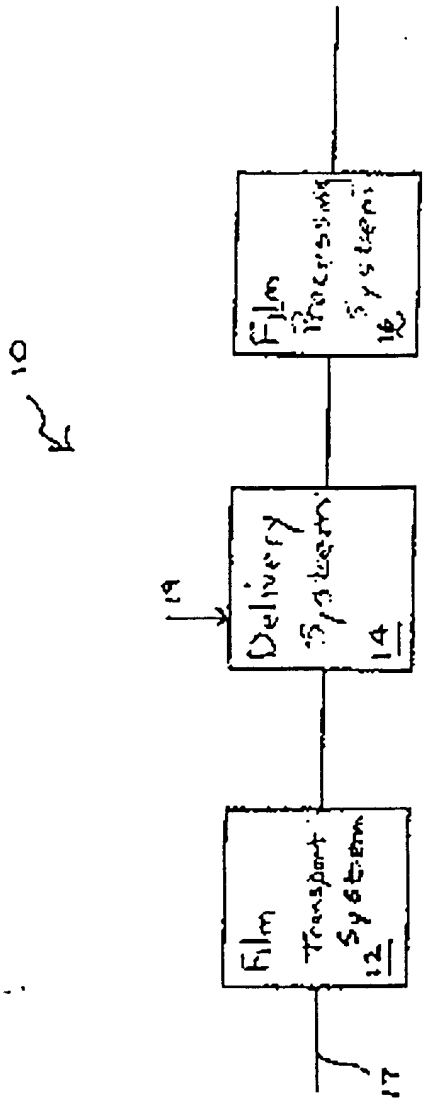
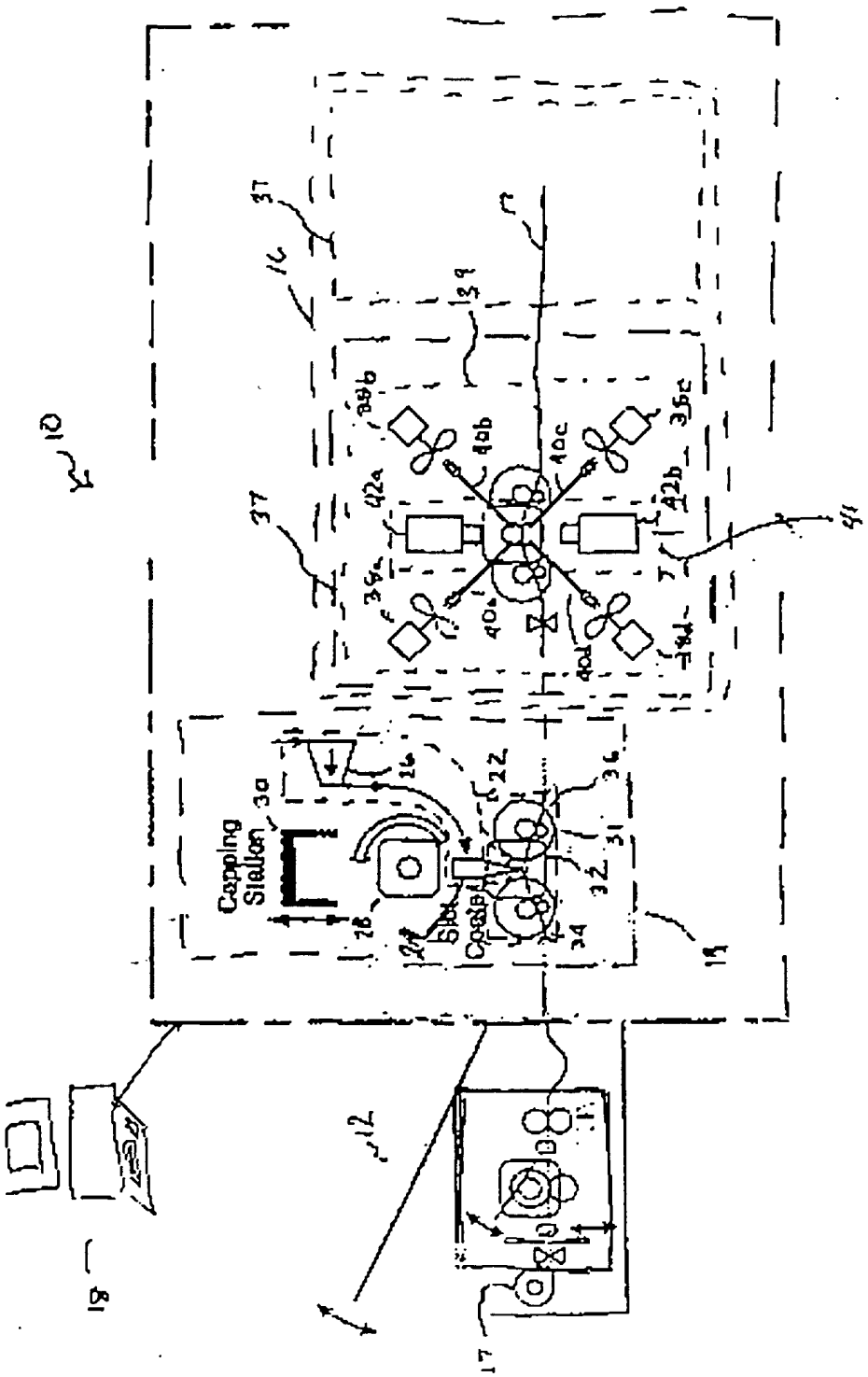

10
Film Transport System 12
Delivery System 14
Film Processing System 16
19
17

Fig. 1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34
36
37
39
40a
40b
40c
40d
41
42a
42b
35a
35b
35c
Capping Station

FIG. 2

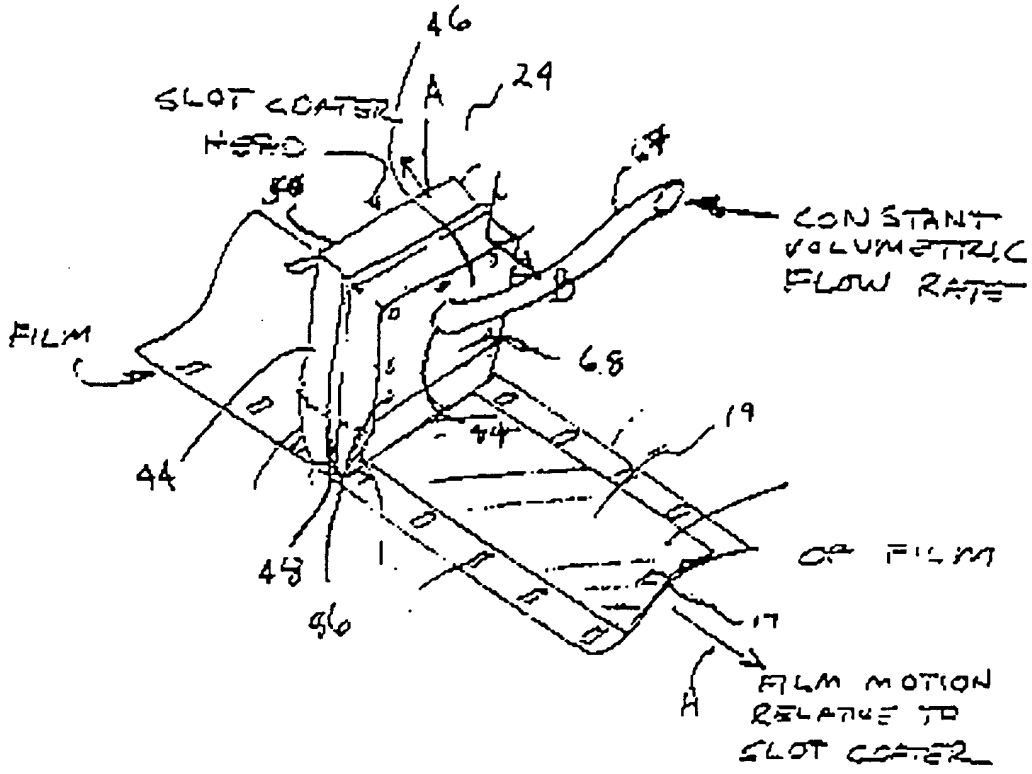

FIG. 3

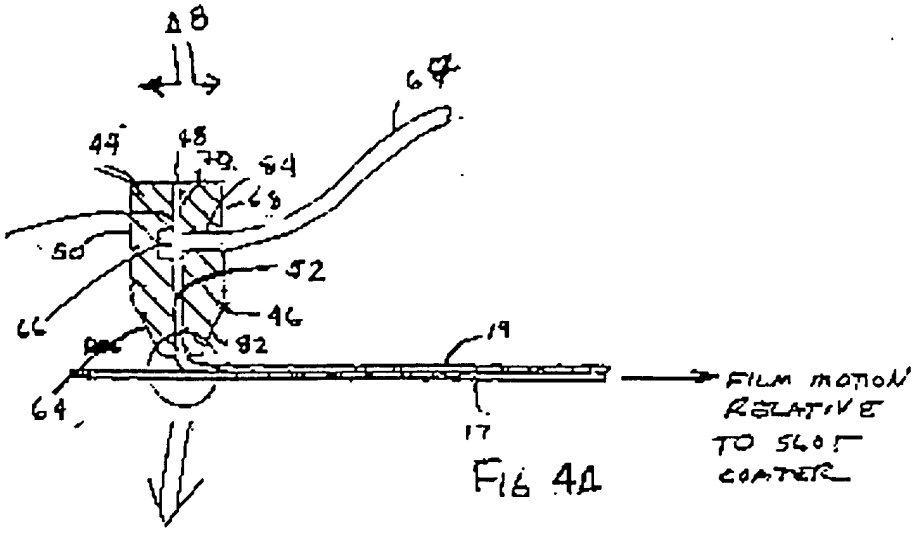

FIG 4A

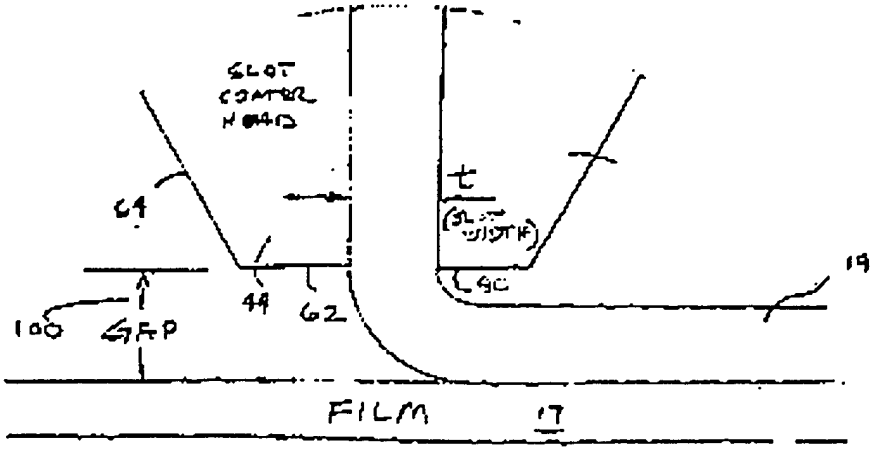

FIG. 4B

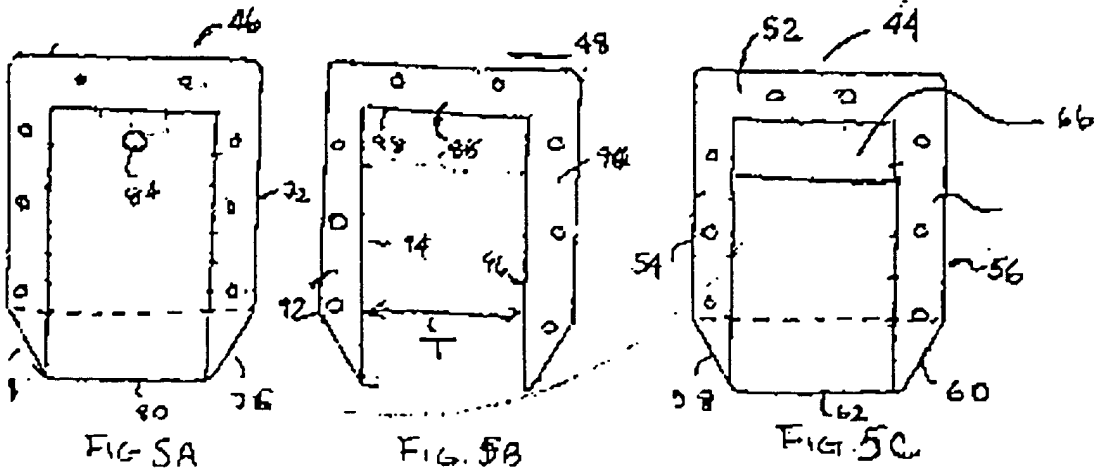

FIG 5A FIG. 5B FIG 5C

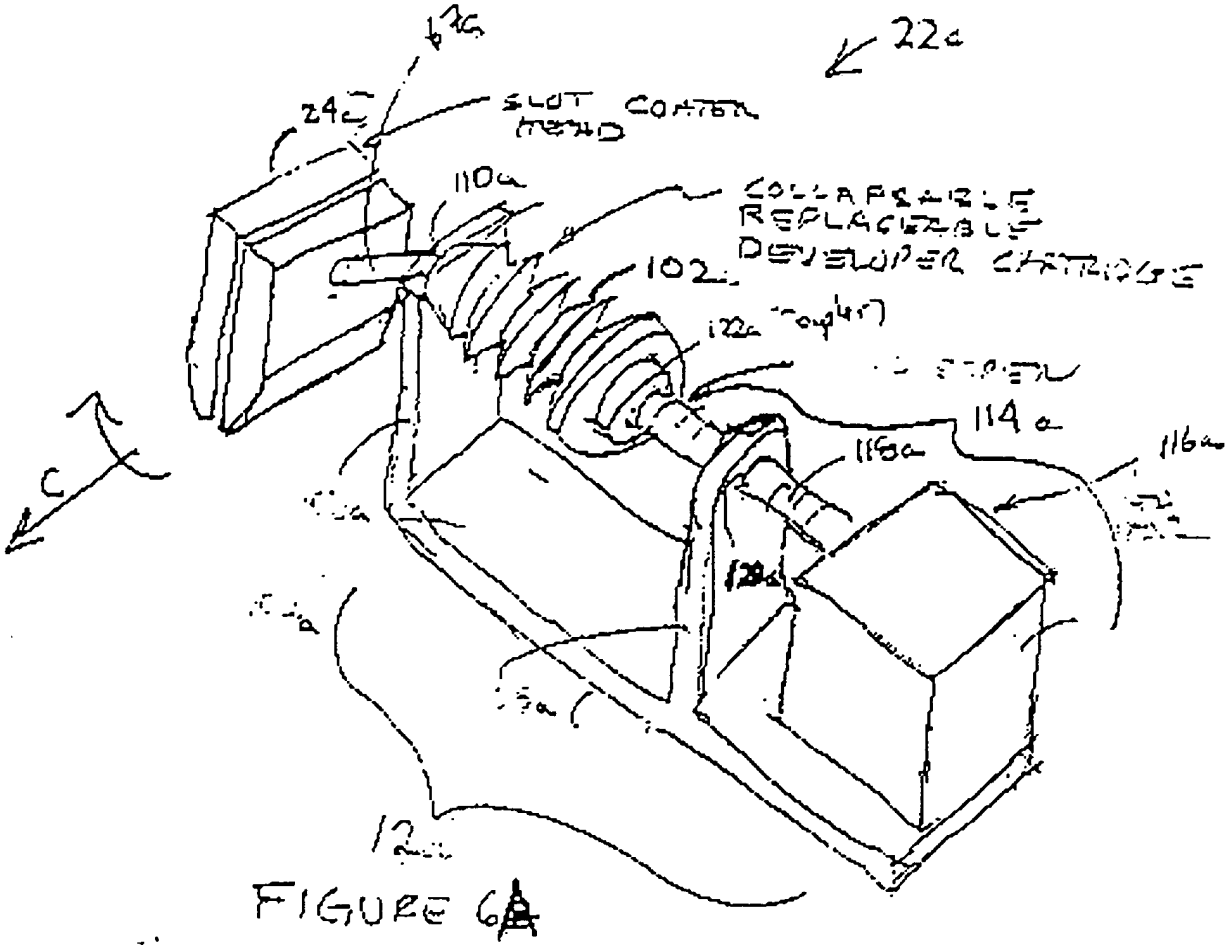
22a
24a
SLOT COATER HEAD
110a
COLLAPSIBLE REPLACEABLE DEVELOPER CARTRIDGE
102
122a
114a
116a
118a
C
12

FIGURE 6A

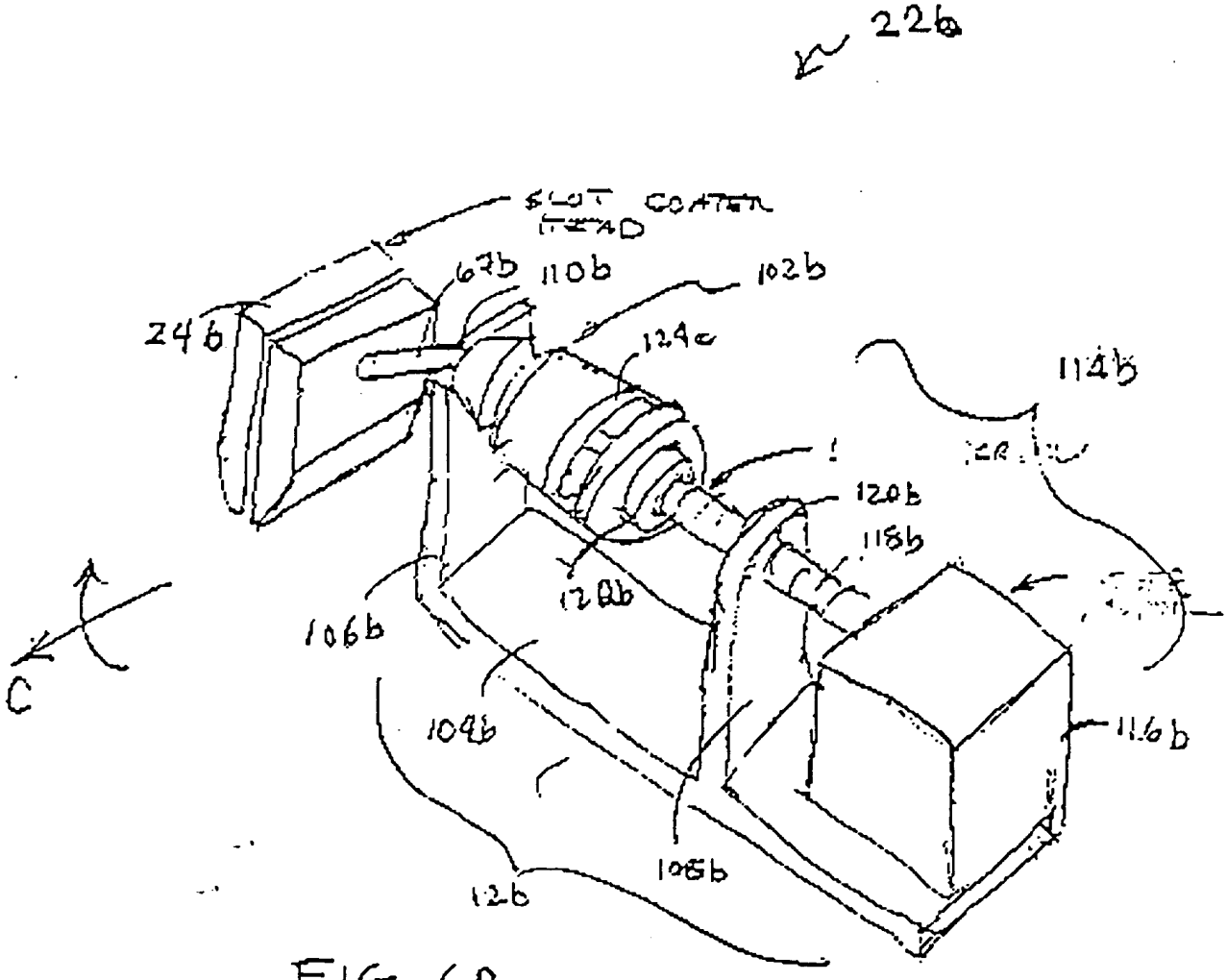
22b
SLOT COATER HEAD
67b
110b
102b
24b
129c
114b
120b
118b
128b
106b
C
104b
116b
105b
126

FIG. 6B

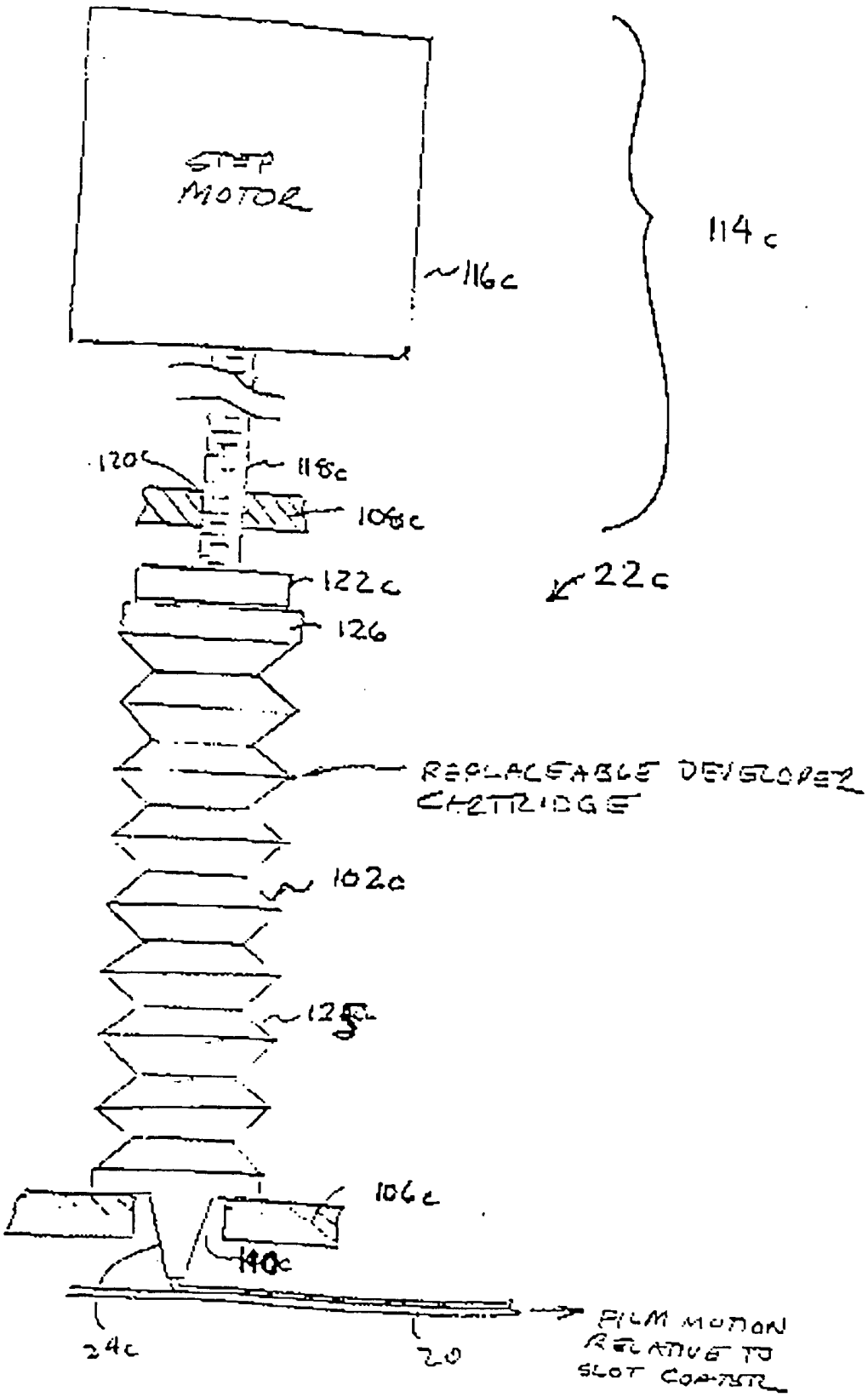
STEP MOTOR
116c
114c
120c
118c
106c
122c
22c
126
REPLACEABLE DEVELOPER CARTRIDGE
102c
125c
106c
110c
24c
20
FILM MOTION RELATIVE TO SLOT CARRIER

FIGURE 3A

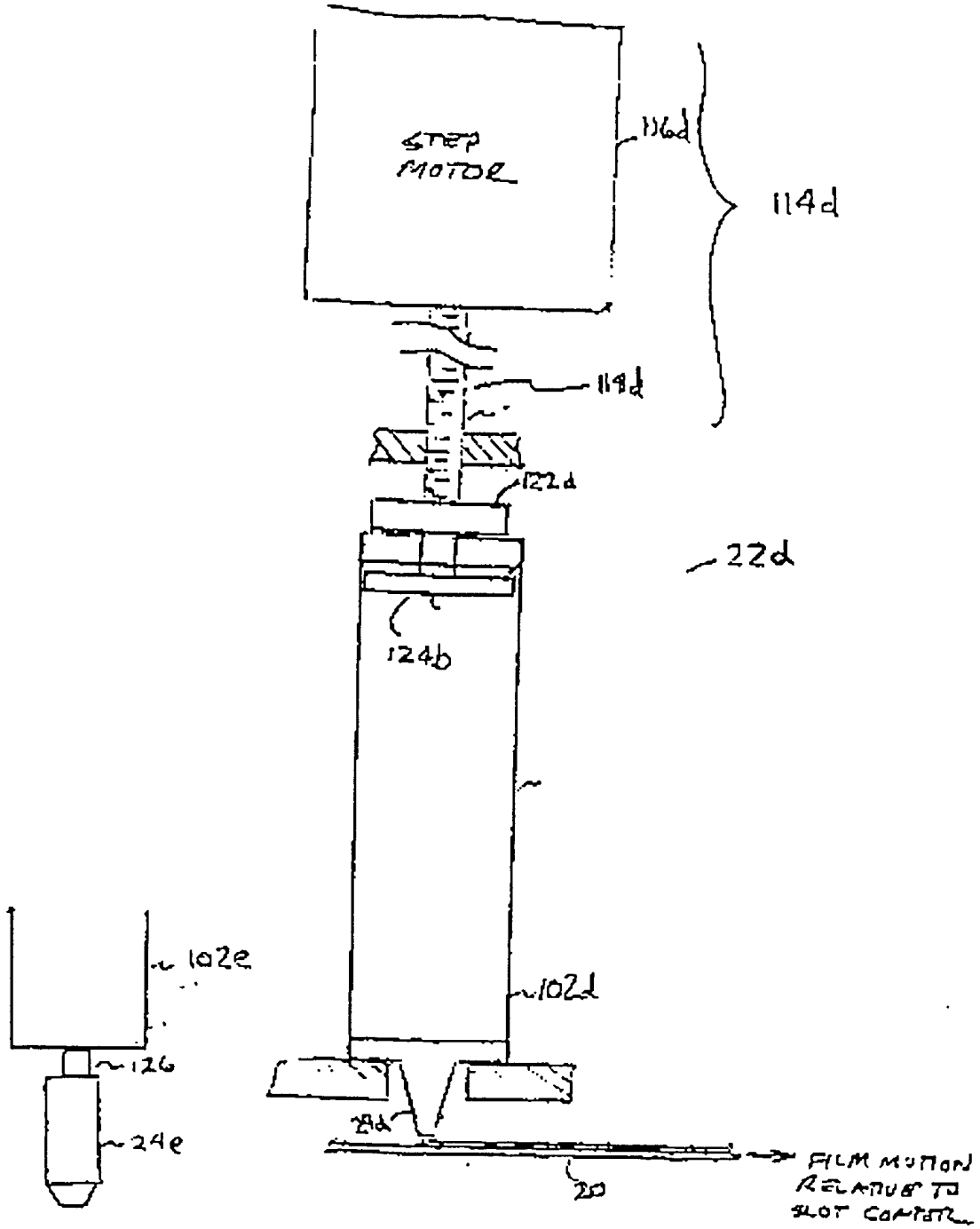
STEP MOTOR
116d
114d
118d
122d
22d
124b
102e
102d
126
24e
28d
20
FILM MOTION RELATIVE TO SLOT CARRIER

FIG. 7C

FIG. 7B

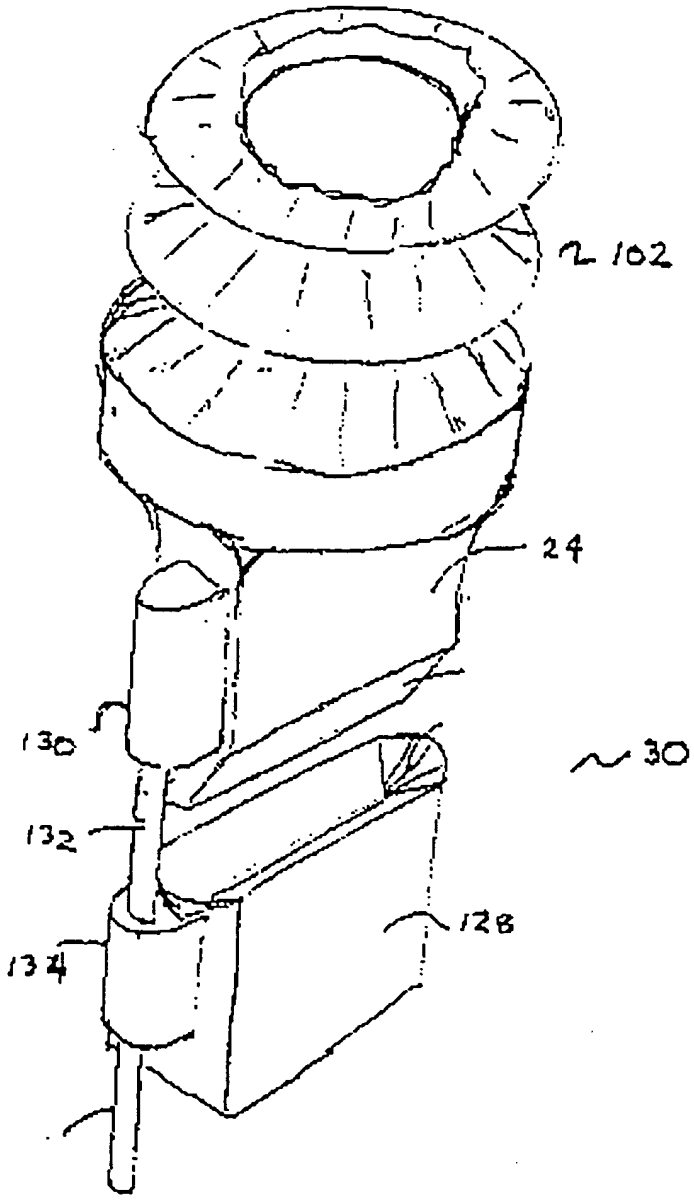

FIGURE 8

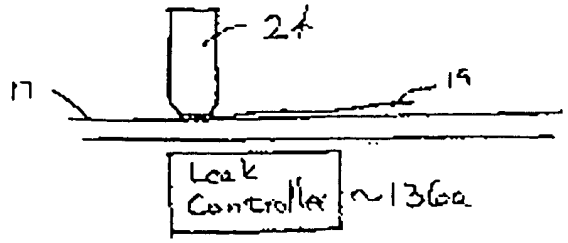

Fig. 9A

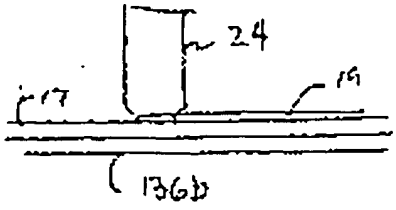

Fig. 9B

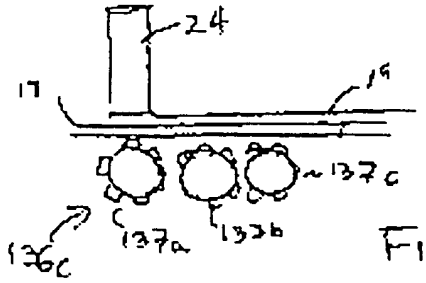

Fig. 9C

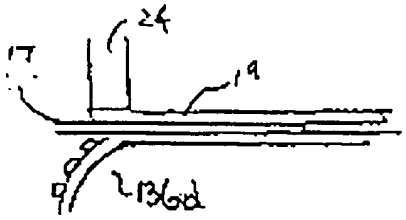

Fig. 9D

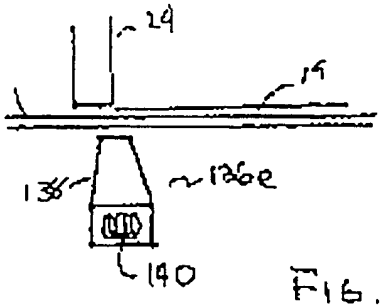

Fig. 9E

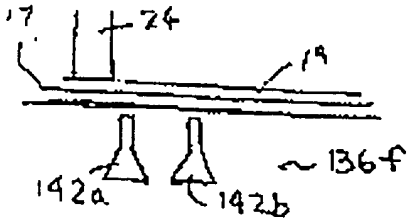

Fig. 9F

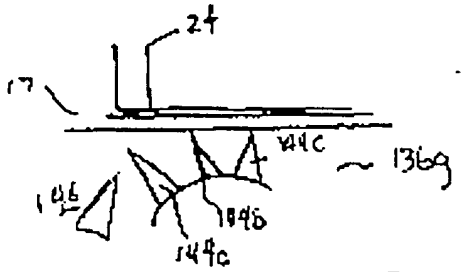

Fig. 9G

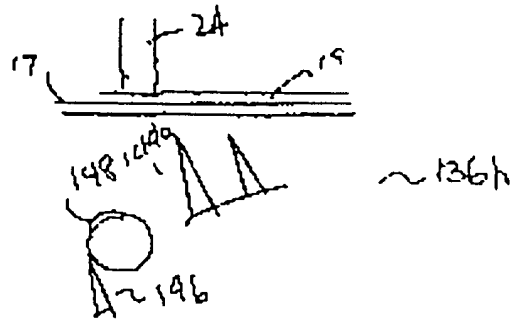

Fig. 9H

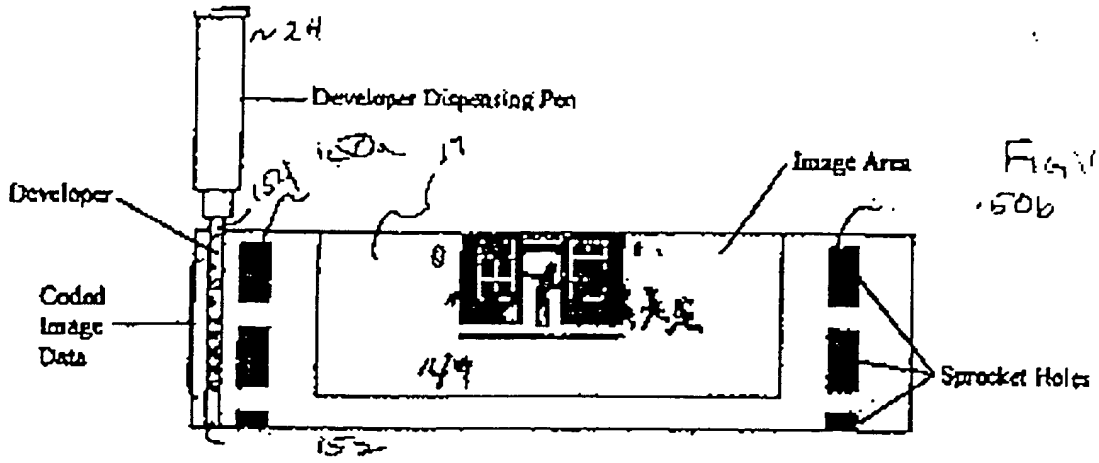
~24
Developer Dispensing Pen
150a
17
Image Area
Developer
152
Coded
Image
Data
Sprocket Holes
154
152

Fig 10
506